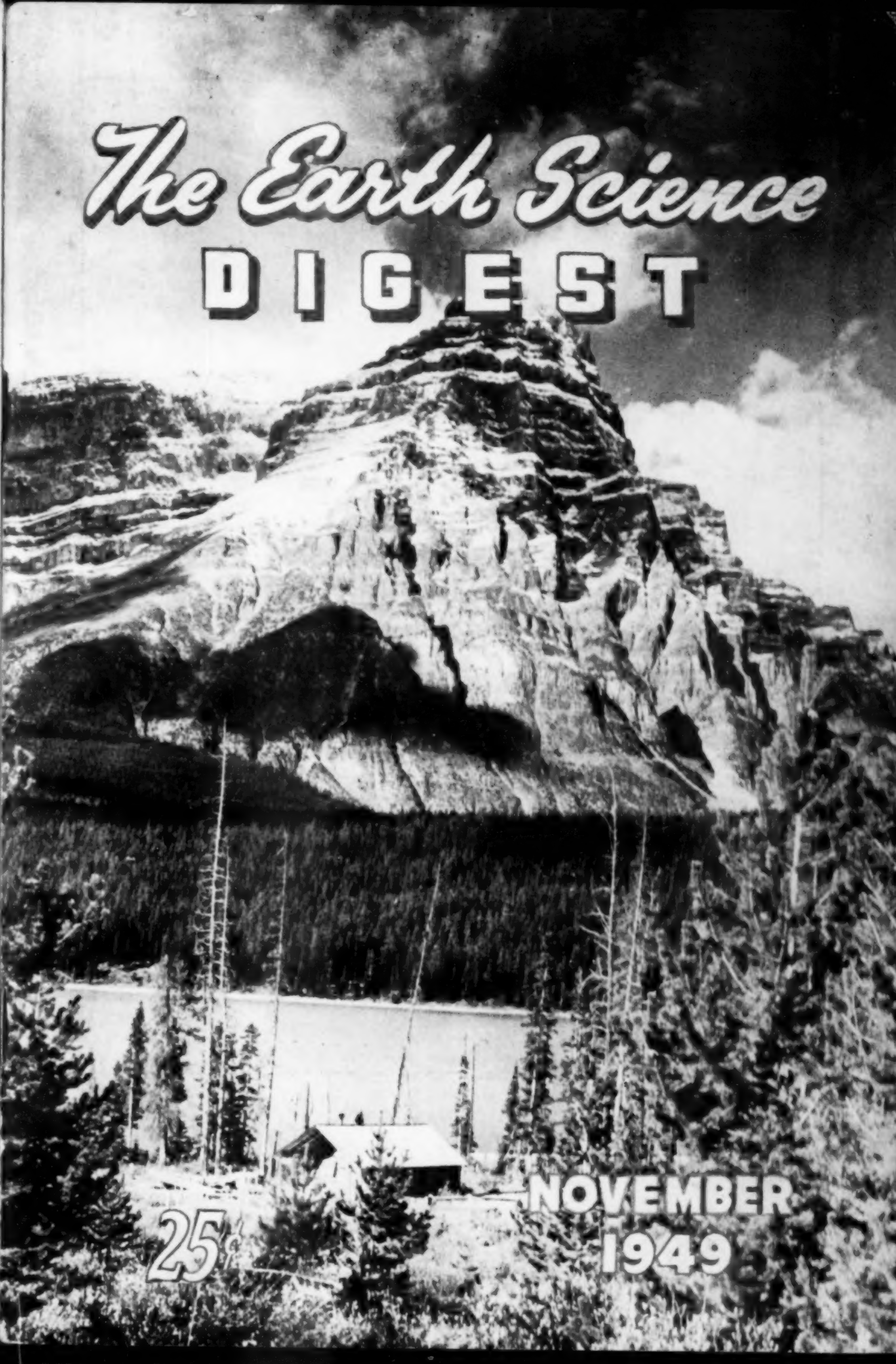
The Earth Science
DIGEST
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NOVEMBER
1949

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S. ALBERT EISENBERG, Publisher

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Meetings and Conventions

American Association for the Advancement of Science, Section E, 116th Annual Meeting. Dec. 29-30, 1949. Hotel Statler, New York.

Earth Science Institute, Annual Meeting. March 17, 1950. Boston.

Conference on the Teaching of the Earth Sciences in the Secondary Schools. March 17-18, 1950. Boston.

National Speleological Society, National Convention. March 31-April 2, 1950. Dodge Hotel, Washington, D. C.

American Association of Petroleum Geologists, 34th Annual Meeting; Society of Economic Paleontologists and Mineralogists, 23rd Annual Meeting; Society of Exploration Geophysicists, 19th Annual Meeting. April 23-28, 1950. Chicago.

Micrometeorites May Be Found In Geological Strata

ROCHESTER, N. Y., Oct. 24 (Science Service) -- Sifting into the earth's atmosphere at about 850 miles per hour or less are little fragments of comets that promise to provide valuable samples of matter from outside the earth.

Dr. Fred L. Whipple of Harvard College Observatory, Cambridge, Mass., told the National Academy of Sciences meeting here about these *micrometeorites* which are so small that they can smash into our air without being burned to nothing.

A world-wide search for this meteoric dust was suggested. It could be captured in the upper air through airplane flights, recovered from melted snow of remote polar regions, or discovered in the depths of the ocean or layers of the earth formed in past geologic ages.

These particles are very small, the largest being about a ten-thousandth of an inch. Because they are so tiny their large surface compared with their weight allows them to get rid of the heat that is caused by hitting the air molecules. Thus they do not burn in a flash of light like the larger meteorites seen in the night sky. They fall to earth as fine dust.

The comet dust can be identified because it is sharp edged instead of being rounded like volcanic material, wind blown particles or fine material from power plants and other earthly fire. Even the small fragments of the larger meteorites or fireballs should be fused and smooth.

Investigations have been made so far on micrometeorites by Drs. D. K. Norris and Fran Hogg of Toronto and Dr. H. E. Landsberg of Pennsylvania State College.

There is hope, Dr. Whipple said, that micrometeorites found in the geological layers can tell us about the history of the solar system. He suggests that deposits of the Cretaceous era should be searched for evidence as to whether the solar system was filled then with more fragments of planets and other cosmic material, as some astronomers have theorized.

For his researches on meteorites, Dr. Whipple was presented with the J. Lawrence Smith medal of the National Academy of Sciences, one of the highest awards of American science.

Low Cost Maps Available To Public

WASHINGTON, D. C., Nov. 13 — A total of more than 3,000 reports and 7,000 maps are the result of systematic studies published by the U. S. Geological Survey since its inception in 1879 "to classify the public lands and to examine their geologic structure, mineral resources and products".

According to Dr. William E. Wrather, Survey Director, these provide the basic information concerning our nation for use by State and Federal agencies as well as private enterprise engaged in conservation, development and use of the nation's water, mineral and land resources.

"All too many people", he says, "do not realize the privilege that is theirs of purchasing accurate topographic maps covering those local areas of the United States which have already been mapped". About 500 new ones will be published this year representing some 22 million acres. Copies can be obtained, usually at 20 cents each, by addressing the Director, U. S. Geological Survey, Washington 25, D. C. An index map of the entire country or of individual states showing those areas already mapped and the degree of accuracy, can be had free upon request.

GEOPHYSICAL EXPLORATION WITH THE AIRBORNE MAGNETOMETER

HOMER JENSEN
Aero Service Corporation

The increasing need for the raw materials of the earth and the advanced state of surface exploration have exerted in the past few years, and will increasingly exert, a strong demand for all types of geophysical exploration.

Geophysical exploration differs from geological exploration in that the examination of physical qualities takes place at a distance from the rocks being examined. Hence certain of the physical aspects of materials, such as hardness, color, texture, and so on, which are useful in the exact determination of rock types, must be abandoned in geophysical work; and certain other physical aspects, such as specific gravity, elasticity, conductivity, and magnetic susceptibility, which can be measured at a distance, assume importance. These properties give more general descriptions than the detailed ones given by direct examination, but they can be most useful for determining structures, and, in some instances, for the identification of ore bodies.

Specific gravity can be measured by the gravity meter, which detects small differences in the amount of gravitational field, resulting from local variations in the density of the rock. Elasticity can be measured by the seismograph, which times the transit of sound waves through the rocks. By the nature of the quantities being measured, both these measurements must be made from the surface of the earth, or in some instances from boats on the surface of the sea.

Electrical conductivity can be measured by observing what amounts to an electrical "echo" from a transient current sent through a coil of wire, the nature of the "echo" being determined by the conductivity of the rocks in the immediate vicinity. Theoretically, such measurements can be made from a low-flying aircraft, but since the measured echo will vary inversely as a high power of the altitude, the significance of the results may be very hard to ascertain, as to whether they arise from rock-type changes or small changes in plane altitude.

There remains the measurement of changes in the magnetic field, as affected by the rocks in the vicinity. Since certain rocks, such as magnetic and ilmenite, are so strongly magnetic that they can cause notable changes in the reading of nearby compasses, even the grossest instrumentation can be used to make magnetic measurements of some validity in the search for a few limited types of minerals. The search for iron ore has been aided for centuries by magnetic surveys.

In the past few years, two very great improvements have been made in the instrumentation for magnetic surveys, with the result that at the present time a far greater portion of the earth's surface is being explored by magnetic methods than by all other geo-

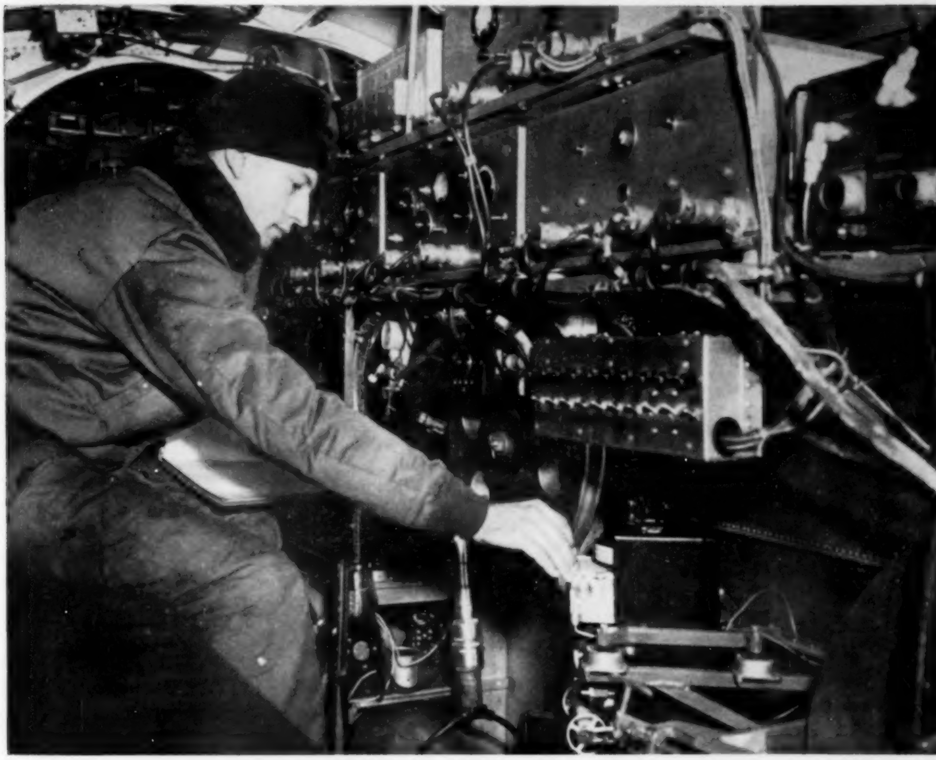
The airborne magnetometer is seen trailing below the survey plane, a specially outfitted Douglas transport, which is pictured here over the waste sludge piles of gold mines in the Union of South Africa.

physical methods put together. The two changes were made at about the same time, and one makes the other possible.

The first great improvement was in the development of "flux-gates" or "flux-valves", electrical coils specially made so that a measurable change in the form of alternating current wave imposed upon the coil will occur in the presence of even a very small magnetic field. These flux-measuring devices are well adapted to use with electronic amplifiers, and hence are capable of great sensitivity, as compared with the older type of magnetometers, which were mechanical devices of limited sensitivity.

With the development of the "flux-valves", it became evident an instrument could be built which could accurately measure the earth's magnetic field, even though on an unstable platform, such as an airplane. In 1941, the Gulf Research & Development Company did develop such an instrument, and it was carried to great perfection by the wartime demand for a sensitive magnetic measuring device to detect submarines.

Today the airborne magnetometer is an instrument of exquisite sensitivity, capable of measuring quantities as small as 1 gamma, or one part in 50,000 of the normal magnetic field in the vicinity of New York. An important difference from the older type of magnetic



The Survey plane is a flying laboratory — a complex mass of electronic instruments to record the airborne magnetometer's indications of the variations in the earth's total magnetic intensity.

measurements lies in the fact that since a valid vertical reference cannot be found aboard an erratically moving platform such as an airplane, the airborne magnetometer measures the total amount of magnetic field while the old ground instruments measured the vertical components.

To free it from the magnetic effects of the airplane's structure and the electrical currents in the skin and wiring of the plane, the magnetometer detector is usually carried below the airplane in a streamlined plastic case called a "bird," at the end of a cable some 75 feet in length. Measurements are recorded continuously in the airplane on a roll of chart paper, and are correlated at frequent intervals with a record of the plane's position. This position is usually established photographically, in some instances by the use of a novel "strip camera" which makes a continuous photographic record of a strip of ground as much as 800 miles long, on a single photograph. Where visual recognition is difficult or impossible, position is established by the use of a radio distance-measuring device, known as Shoran.

The first complete experimental surveys were conducted by the U. S. Geological Survey in the spring of 1944. In the summer of 1945,

The sensitive airborne magnetometer is enclosed in a bomb-shaped plastic case. Here it is seen before being raised into its "cradle" beneath the plane, before take-off.

the first large-scale magnetic survey was made, of some 35,000 square miles in northern Alaska.

In January of 1947, the Aero Service Corporation of Philadelphia conducted the first commercial survey with high-sensitivity airborne magnetometer, seeking new mineral deposits in Ontario. Since that time, more than half a million square miles of the earth's surface have been covered by magnetic survey with the high-sensitivity air-involved being almost equally divided between oil and mineral surveys.

A typical survey will consist of a systematic set of parallel flight lines covering the area under investigation, and separated by an interval ranging from one-eighth mile to two miles, depending upon the detail to be registered. Again depending upon the detail to be recorded, the altitude ranges from 300 feet to 1500 feet, the lower levels being used for mineral surveys, the higher for petroleum surveys.

A set of lines approximately at right angles to the traverse lines will intersect all the traverse lines, and by thus giving two systems of readings for a large family of intersections throughout the area, will provide a statistical base against which corrections may be made for all the variable factors which affect magnetic measurements in a survey. This analysis can be carried to so high a point that precise maps of 1-gamma contour have been produced.

Some of the variables which require control correction are instrumental; some arise from basic geomagnetic considerations. Among the instrumental factors are drift and heading effect, the former due to changes in electrical characteristics of the magnetometer during flight, the latter being due to the variations in the measured effect of the airplane upon the magnetometer, depending on their relation in space. That is, slightly different readings will be made depending on whether the plane is headed north or south, but the difference will be a constant while on the particular heading.

The variable most difficult to correct is the normal diurnal variation of the earth's field. This variation is different from day to day, and is, in general, not predictable. It will amount to as little as a few tens of gamma, or as much as many hundreds, and may amount to many gamma in just a few minutes. On normal days, the control procedure is adequate to remove the effect of this changing environment; and a separate monitor station is operated at the survey base to permit cancellation of the flight if unusually severe variations begin to occur.

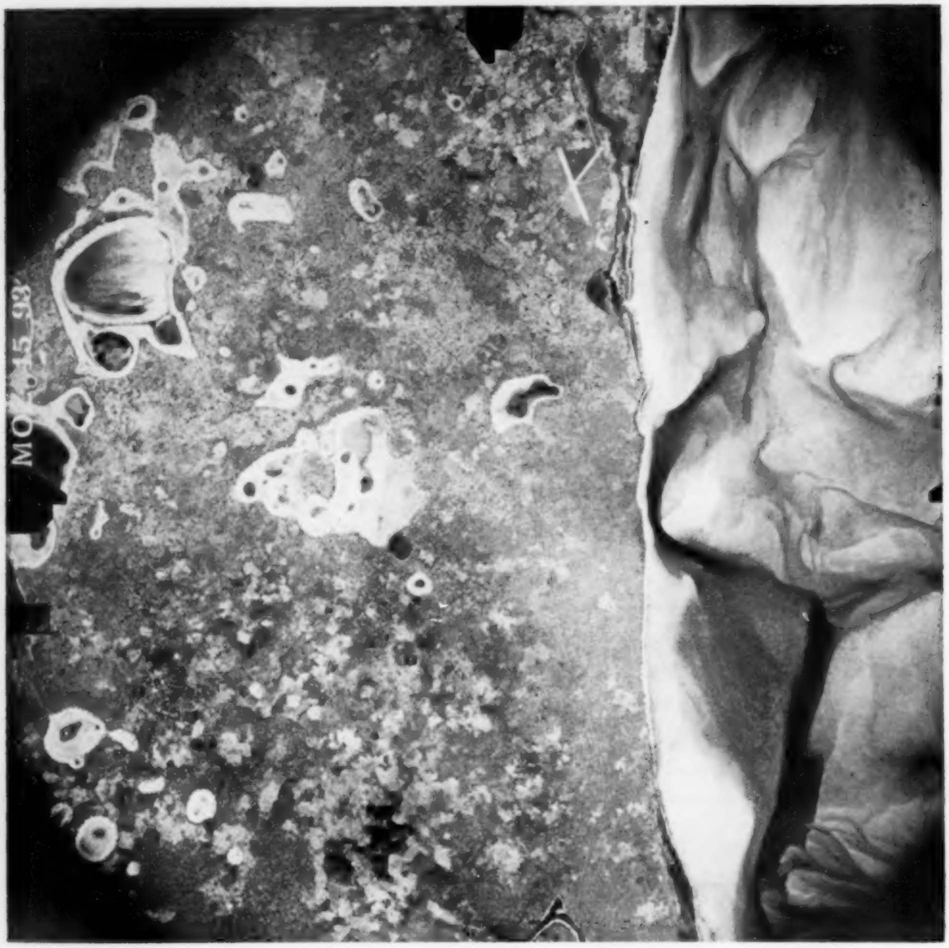
However difficult may be the cancellation of the effects of the diurnal variation on the airborne survey, the resulting correction is so much more precise than is possible on the ground that it forms an important factor in the superiority of the air method. It can easily be seen that if the measuring device moves miles during a brief time interval, the effect of a time variation of the field will not be as serious in the compiling of a map, as if the measuring device moved only feet, and the errors were then mapped, in effect, as so many gamma per foot, instead of the same number of gamma per mile.

Another great advantage of the airborne method lies in the continuity of record obtained. In essence, it means that (a) no false magnetic figures will be mapped, and (b) all true magnetic figures will be mapped. Neither of these is true in the point-by-point ground method, where a smooth curve is drawn by hand to connect a set of separately made measurements. On the ground, a single station may register a high value which will later be worked into a smooth curve connecting its adjacent values, whereas the magnetic reading may be entirely local, as from a pipe buried in the road, and therefore of no geological significance. Oppositely, a small magnetic disturbance of true geological significance may be missed entirely, if it happens to lie between the measuring stations.

A further advantage of continuity lies in the recognizability of the curves. For instance, it happens frequently that in a set of parallel traverses a family of similar record traces will appear, thus clearly marking the persistence across the traverses of some linear geological structure, such as a dike, or an outcropping bed somewhat more magnetic than its environment. This situation has proved extremely useful in the magnetic surveys made by the Geological Survey in northern Michigan in the search for extensions of the iron ore bodies in the region. In this area the ore is hematite, which is only weakly magnetic, but the ore lies in a fairly constant relation to some strongly magnetic horizons. Thus it is possible to trace the magnetic horizons very clearly across miles of country, in spite of an unbroken gravel overburden a few hundred feet thick, through the appearance of the characteristic magnetic curves on successive traverses. Using the magnetic horizon as a point of departure, it is possible to predict the probable location of the related hematite beds.

A positive identification of major rock contacts, such as that of anorthosite and granite, is also possible through magnetic surveys, in spite of impenetrable overburden or impassable terrain. Here again, a characteristic type of magnetic trace will appear at the contact, so it is possible for a geologist in an airplane to sketch hundreds of miles of contact in a day, merely by watching for the appearance of the contact signal as the plane flies along.

A very crude analogy may be useful in visualizing the action of the magnetic field in relation to geology, instead of to small magnets which form the basis of normal experience with magnetics. The distribution of magnetic flux as it is affected by passage through rocks of differing magnetic susceptibility is much like the flow pattern of distribution of water as it would be affected seeping through sand beds of differing permeability. Hence there would be a high flux through and above sands of high permeability to the flow of water, and a low flux through sands of low permeability. Immediately adjacent to the level of the sand beds, the flux pattern would be highly complex, as it was affected by every pebble and every variation in the bed, but further from the beds, the pattern would tend to smooth out, and would show only the integrated effect of large areas of the beds. At a sufficient distance,

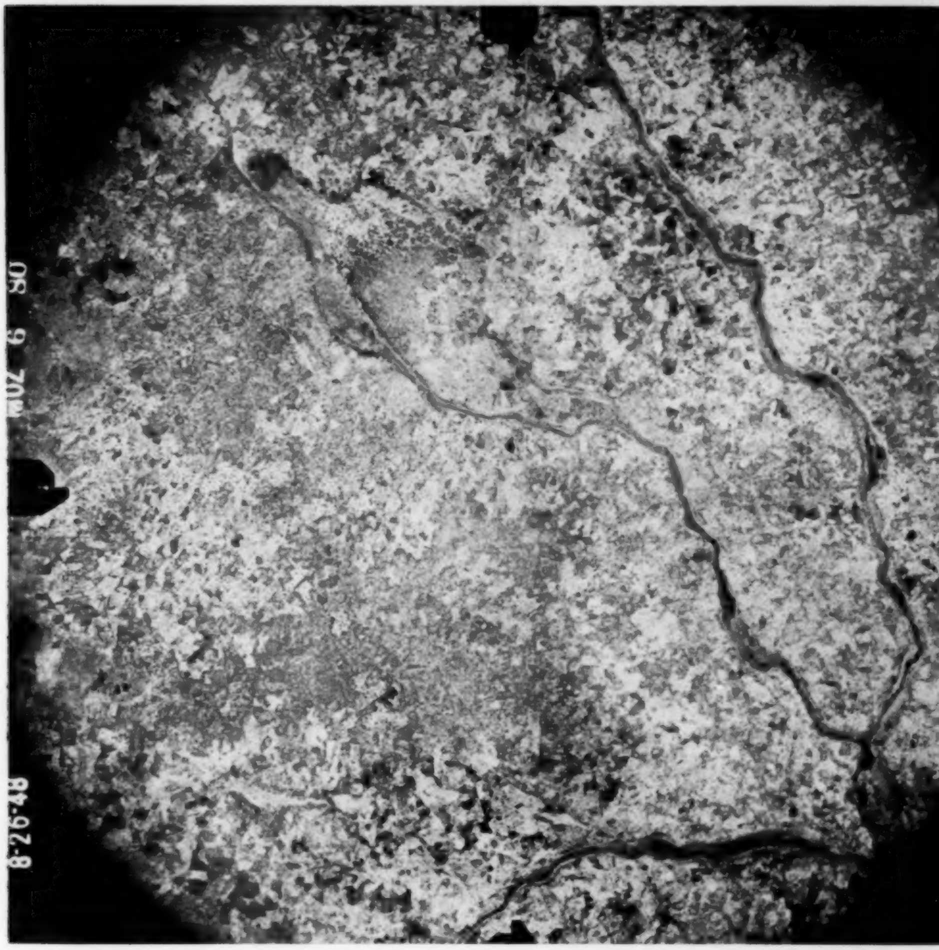


A typical section of the coastal area of southern Mozambique photographed from a height of about three miles. Note the clarity with which the underwater details are shown (right). A dry lake bed (center), lakes (left), channels of coastal currents (lower right), small farms (lower center), and the airstrip near Vilanculos (upper center), may be seen in this photo.

the flow would again be entirely uniform.

Similarly with the magnetic field: immediately above rocks of varying magnetic permeability, the magnetic flux pattern is highly complex, showing maximum values over highly permeable bodies and minimum values over bodies of low permeability. As the altitude is made greater, there is a smoothing out, and a loss of detail. This smoothing out is the only serious limitation to the airborne method and rules it out where the terrain is so rough that the airplane can't get sufficiently close to the ground or in instances where the geological detail is too fine to register.

The orderly way in which the magnetic field smooths with distance from the disturbing body

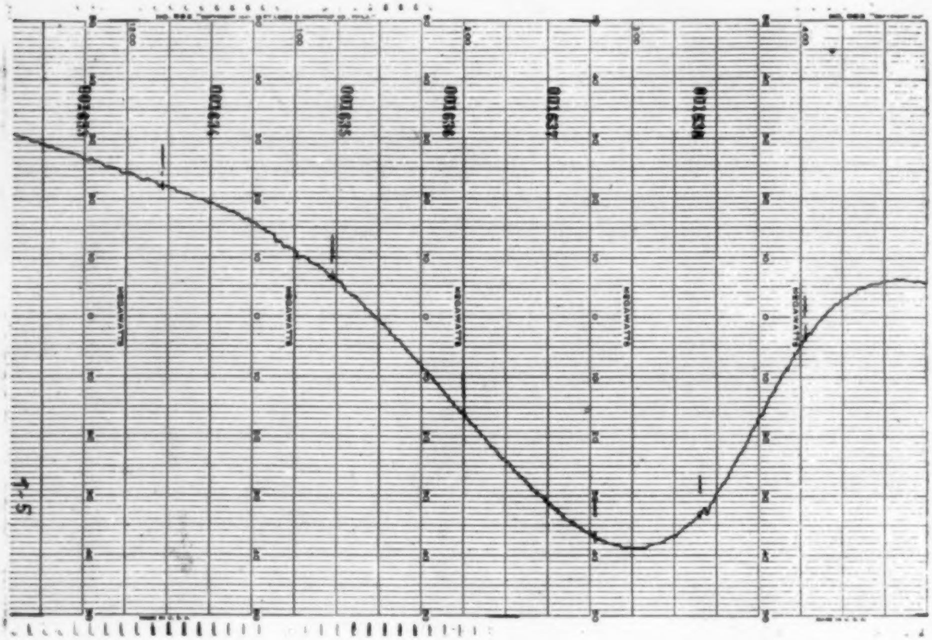


A representative inland terrain in the Mozambique survey area photographed from a height of about three miles.

forms one of the principal means by which magnetic measurements become useful in the search for oil reserves.

In general, neither petroleum nor the host rocks in which it is found are magnetically much different from air, but the underlying rocks below the oil-bearing sediments, are highly magnetic. By a careful mathematical analysis of magnetic map it is possible to estimate the distance to the magnetic beds, and hence to approximate the thickness of the sediments — an important factor in oil exploration. It is also possible to detect major uplifts in the "basement" rocks, and hence to estimate the presence of associated structures in the oil-bearing sediments.

In mining exploration with the airborne magnetometer, the evidence is often more direct. Certain rocks — magnetite, ilmenite, and others are highly magnetic, and hence will show up very obviously in an accurate magnetic map. If



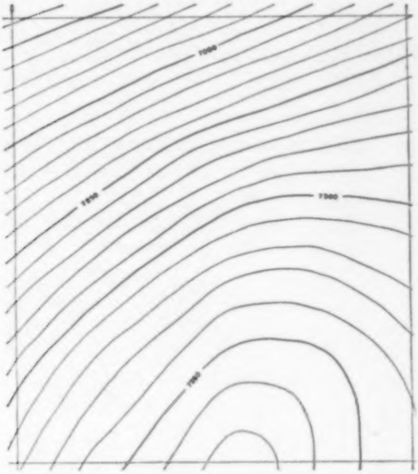
A TYPICAL AIRBORNE MAGNETOMETER TAPE RECORD

the exploration problem is to find these ores, then the solution to the problem is easy indeed. Certain placer concentractions are also directly detectable, due to the associated concentrations of magnetite in the sands. More often, the ore being sought is only slightly magnetic, and then the exploration and the interpretation of the magnetic maps become much more of an art. In many cases, the significant magnetic figures are very small compared with the figures caused by disseminated magnetite or other non-economic sources. Then, there are many other cases, such as the hematite exploration referred to earlier, where the ore itself is non-magnetic and only associated rocks can be mapped.

A useful aspect of magnetics is that mineralization in general is associated with higher magnetic concentrations, and hence can usually be detected by sensitive magnetic measurements. Small dikes and other intrusions will show up, if the environment is sufficiently non-magnetic that the figures will not be lost in the confusion.

One great advantage in the use of the airborne magnetometer is entirely negative. With this instrument, it is possible to make a survey of a remote area without ever touching foot in it, and to come back with general answers as to which areas should be *eliminated* from consideration, and which areas justify additional exploration.

In very few cases is the magnetic information itself sufficient to justify final conclusions. It must either be preceded or followed by careful geological and geophysical analysis to determine first whether a magnetic survey will give significant information, and later to



From the tape and detailed position records, a magnetic intensity map such as this was made for the Bahamas Survey, which covered an area bigger than Kansas. A section of the representative map is shown here.

decide just what the information means.

It is only in the past few years, or even months, that magnetic maps of the very high precision now being produced by the airborne magnetometer have been available to geologists and geophysicists. So far, surveys have been made primarily in those fields where the magnetic method has historically had a recognized place, and the airborne method has been chosen primarily because of its accuracy, speed, and economy. It is quite possible, however, that entirely new pages are being opened by the new instrument, and that the new higher order of sensitivity may make the magnetic method useful in problems where it has never before been considered. The existence today of valid 1-gamma maps is something hardly dreamed of a few years ago; and the applications of maps of such sensitivity may be justified in circumstances not dreamed of today.

Photos courtesy of Aero Service Corp.

Bones of Birds Which Could Swim Are Found

LOS ANGELES, Calif., Oct. 11 (Science Service) — A jig-saw puzzle of fossil bird bones has been put together by Dr. Loye Holmes Miller, professor of zoology, emeritus, at the University of California at Los Angeles, to reveal the existence of a small, penguin-like bird that existed in southern California more than 3,000,000 years ago.

At that time most of the city of Los Angeles was under water and the flightless fowl, called Mancalla, paddled around with flippers which, in previous ages, might have been wings.

The first evidence of the birds' existence was discovered 50 years ago when a single bone was dug up during the excavation for the Third Street tunnel in downtown Los Angeles.

Since then a number of fossil remains have been unearthed at various places in southern California. Sufficient remains now exist to furnish a rather accurate picture of the Mancalla.

Why did the Mancalla, member of the auk family, become extinct? At present the reason is not known, says Dr. Miller. Far to the south, birds of similar qualities, members of the albatross tribe, managed to survive. We know them as penguins.

Cover Photo

Stratified rocks, upheaved ages ago and gently tilted, form the peaks along the spectacular Banff-Jasper (Columbia Icefield) highway, which was opened to the public several years ago. This photo of Banff National Park, Alberta, Canada, is by H. P. Zuidema.

Gulf Dedicates New Geophysics Laboratory

PITTSBURGH, Oct. 21 (Science Service) — Humanity will be faced with catastrophe within a period of a few centuries through exhaustion of our fossil fuels, oil and coal, unless science can come forth with fundamentally new discoveries, Dr. Paul D. Foote, Gulf Oil research director and vice-president, declared at the dedication of the Leovy Geophysics Laboratory, at Harmarville, near here.

These new discoveries will be made if research is adequately supported, Dr. Foote declared. Any moratorium on science and technology would be fatal to economic security, he said, and "the only opportunity for continually improving our standard of living is the most intensive development of science and technology." He predicted discoveries in the production and utilization of energy surpassing anything we know today.

Named for Frank Adair Leovy, Gulf Oil Corporation pioneer in scientific oil exploration who died in June, the new laboratory is the world's largest building devoted to research on oil prospecting.

Four producing oil wells are struck by geophysical methods to every one found by unscientic oil prospecting.

Over half of the new building's 126 modern rooms are devoted to interpreting prospecting data from more than 500 prospecting parties in all parts of the world, many of them air-borne. Aerial prospecting crews using a Gulf-developed magnetometer survey hundreds of miles of territory a day.

WATER RESOURCES

OCTOBER, 1949

Streamflow throughout Canada, New England, and the Southwest was generally below normal. Elsewhere streamflow was generally above normal with excessive runoff in the Great Plains and in the South, where local floods occurred. Record-breaking floods occurred in streams in and around Houston, Texas, and local floods in North and South Carolina were the highest since at least 1940.

In the Northeast, drought conditions continued unabated with prospect of improvement dependent upon above-normal precipitation. Deficient runoff in southern Alberta, southwestern British Columbia, and southern California continued with little change.

WATER YEAR 1949

The 1949 water year (ending Sept. 30, 1949) was characterized by near-normal volumes of runoff in major portions of the United States. In Canada annual runoff was dominantly below normal. Excessive runoff prevailed in the Southern States, where widespread floods occurred twice during the first half of the year. Local floods of unusual magnitudes were recorded in all seasons of the year, chiefly east of the Rocky Mountains. Ground water conditions were generally favorable.

— *Water Resources Review*

RECENT RESEARCH IN SUBMARINE GEOLOGY

The following report is based upon the papers presented at the Symposium on Submarine Geology held at the 62nd Annual Meeting of the Geological Society of America, Nov. 10-12, 1949, at El Paso, Texas.

Submarine Geology: Swedish Deep Sea Expedition; 1947-1948 (Hans Pettersson, Goteborg, Sweden).

The study of submarine geology up to the last decade has been restricted to the very uppermost of the sediments carpeting ocean floors, the thickness of the carpet being unknown. By using a "piston core sampler", cores of the ocean bottom 10 to 15 meters in length were obtained. (This instrument utilizes the high water pressure at great depths by forcing the sediments upward into the tube, while the tube is pressed into the sediments by a heavy weight.)

Changes in conditions and in the level of the sea bottom are indicated by the more or less pronounced stratification of the cores, which were taken in the equatorial waters of the Atlantic, Indian, and Pacific oceans. Foraminifera from the open Atlantic, Caribbean, and Mediterranean were analyzed. They indicate considerable change in surface temperature pointing to the evidence of glacial and interglacial periods. Hard bottoms at places in the Pacific and Indian oceans, probably relatively recent lavas, inhibited coring. Some of the Pacific deeps contained coarse fragment layers.

Echoes of depth-charge explosions were recorded in order to locate reflecting layers of the sedimentary carpet. (In this procedure a small bomb is exploded astern the ship. The top of the sediment reflects the first weak echo of the explosion. The rockbed below reflects the second strong one. By recording the time interval between the two echoes, the thickness of the sediment can be estimated. Sound generally travels about 4500 feet a second through these sediments.)

The greatest depths for obtaining reflecting surfaces were reached in the open Atlantic, Caribbean and Mediterranean. Lava sheets are probably the cause of the obstruction of the sound waves in the Pacific and Indian oceans, which confined the reflecting surfaces to a few hundred meters below the ocean bottom.

Work was generally inhibited by the rugged bottom topography common in all three oceans. Extensive flat surfaces are rare in open oceans, being found most often in the Caribbean, Mediterranean, and Sundra seas. Faulting is suggested by hummocks and distinct steps, 50 to 100 meters high, which were common.

Dr. Pettersson recommended the co-ordination of research in submarine geology on an international scale. He indicated these lines of research: Taking and reporting of echo soundings; deeper corings, improving sediment sounding techniques; measuring thermal gradients below the sediment surface;

determining the radioactivity of cores; and the sampling of hard bottoms.

Submarine Topography In The North Atlantic (Ivan Tolstoy).

The continental slopes commonly possess a steplike succession of horizontal or slightly sloping shelves or terraces. Systems of submarine canyons, probably of subaerial origin, dissect the slopes. A recent investigation has shown that the Hudson submarine valley extends at least 300 miles out to sea, at about the 2200-fathom curve.

The broad ocean basins are characterized by smooth floors, covering areas of more than 100,000 square miles. Large sea mounts, isolated or in groups, rise from these basins or plains. The floors of the North American and North Canary basins are occupied by plains at a depth of 2900 fathoms. There is a plain at 2650 fathoms on the ocean floor north of Bermuda. On the 2650-fathom plain of the western North American basin there is a conspicuous group of flat-topped sea mounts, showing evidence of terracing on their flanks. They range roughly from the direction of Cape Cod toward the southeast, rising approximately to 800 fathoms.

The Mid-Atlantic Ridge is a long submarine mountain range in the central Atlantic Ocean, extending from Iceland to a point southeast of the Cape of Good Hope. There is a high central zone, or Main Range, which often rises to less than 800 fathoms below the ocean surface. A succession of flats on the flanks of the Ridge between 1600 and 2500 fathoms have been called "terraces". These terraces are areas of greater sedimentary deposition. This has been indicated by reflection-shooting studies. A mountainous area stands out as a distinct physiographic province between the Terraced Zone and the 2900-fathom plain.

Seismic Studies In Ocean Basins (Maurice Ewing, Columbia University)

Seismic refraction measurements made at over a dozen North Atlantic stations show in general that the basement rocks may be tentatively identified with those at depths of about 40 kilometers beneath the continents. Measurements indicate that these rocks are covered by unconsolidated sediments to a depth of about 2 kilometers.

Seismic reflection measurements have been made at over 3000 stations in the North Atlantic. On the eastern and western flanks of the Mid-Atlantic Ridge and throughout the Bermuda rise, it is possible to map a buried reflecting surface which is continuous over distances of hundreds of miles. The sediment overlying this reflecting surface is remarkably homogenous, for there are no intervening reflectors. This reflecting surface, which is at depths up to 4000 feet below the ocean floor, is probably the surface of the basement rock.

In other large areas it has not been possible to map reflecting surfaces which are continuous over tens of miles, such as the approaches to the continent, the main basins, and the central highland of the Mid-Atlantic Ridge.

If a new proposed theory of earthquakes surface waves under the oceans is accepted, it will furnish proof that the ocean basins have never stood appreciably higher with respect to the continents than they do at present.

Refraction measurements would give evidence of any former land bridges across the main ocean basins. If there were land bridges, they must have been very narrow, for they not cross any of the areas in which refraction measurements were made.

Properties of The Earth's Crust Beneath The Oceans (Beno Gutenberg, Seismological Laboratory, Pasadena, Calif.)

The earth's crust is divided into two major units. The larger unit consists of the continents, the bottom of the Indian and Atlantic oceans, and possibly parts of the Pacific Ocean, near its borders, which show indications of "continental" layers. These areas are composed of andesitic crustal material. The second unit consists of the Pacific Basin, and possibly outlying areas such as the Caribbean, the area inside the southern Antillean arc, and perhaps an area in the Arctic. These are composed of the younger eruptive basaltic rocks. The boundary between the two units is the Marshall line and the inner boundary of the earthquake belt surrounding the Pacific Ocean.

The geophysical evidence presented for the discountinuity between the Pacific Basin and the "continental" area, and the difference in structure of the Pacific Basin and all other areas, including the bottom of the Atlantic and Indian Oceans is:

(1) The phenomena of great ocean deeps, negative gravity anomalies, and shallow earthquakes in the discontinuous area. None of this and other phenomena is present along the coastal areas of the Atlantic and Indian Oceans, nor is there any other indication of a discontinuity in these areas.

(2) The velocity of surface waves with a period of about 20 seconds is highest inside the Pacific Basin.

(3) Surface waves traveling part of their way along the boundary show a loss of energy up to as high as 90 per cent.

(4) Longitudinal waves reflected under the Pacific Basin have relative smaller amplitudes than in the other areas.

(5) About 80 per cent of all earthquakes are contained in the earthquake belt marking the boundaries of the Pacific Basin.

(6) In the Atlantic and Indian oceans, active belts of shallow earthquakes follow ridges inside these oceans. Earthquake epicenters follow the Alpide belt mountain ranges. Such belts are unknown in the interior of the Pacific Ocean, except for the Hawaiian area.

Recent Results of Suboceanic Geology and Major Earth Problems (Walter H. Bucher, Columbia University).

The results of the recent research carried out in submarine geology challenge current beliefs.

The belief that the Atlantic Ocean floor is underlain by a thin "granitic shell" is questioned by Ewing's conclusions.

The continental drift hypothesis cannot account for the great relief of the ocean floors and its patterns. The basalt floor could not be the "matrix" for the differential movement of the sialic "insets". No evidence has been given to account for the "skimming-off" of the original granitic crust from the ocean basins to form continents. An account is sought for the disappearance of the "once-universal granitic crust of current belief" from the ocean basins.

The suboceanic mountain chains are high because they were raised. "The question is clearly not "Why are the ocean floors low?" but "Why are the continents high?". . . Perhaps the question is, similarly, not

"Why is granite absent from the ocean floor?" but "Why is granite present in the continents?" Perhaps there is nothing "primordial" about granite; perhaps it is a by-product of orogenesis." (From the author's abstract).

The "swell" and basin" structure of the continental surfaces is repeated on a larger scale in the Mid-Atlantic Ridge and its lateral branches. The origin for this structure is as yet unexplained.

The character of the sediments, their rate of accumulation, thickness, distribution, and age, hold the record of the geomorphological agents of the ocean floor.

— *Jerome M. Eisenberg*

NEW EARTH ORIGIN THEORY BASED ON GIANT GAS AND DUST CLOUDS

CHICAGO, Oct. 13 (Science Servive) — Three billion years ago there was a giant cloud of gas and dust rotating around the sun. A few thousand years passed and a thin pancake was formed, a gigantic ring, in the plane of the present planets. Whirling eddies of matter appeared. These shrank and finally condensed into the planets and their satellites.

This is the latest theory of the origin of the earth and the rest of the planets, advanced by Dr. Gerard P. Kuiper, University of Chicago astronomer.

Dr. Kuiper's new theory is a modern version of the early one put forth in 1755 by the German, Immanuel Kant. He speculated that the planets and the sun were formed from a single rotating gaseous cloud.

The mass of the planet-forming nebula around the sun in the Kuiper theory was about half that of the sun. The whirling eddies became what Dr. Kuiper calls "proto-planets", each of which went into the making of its planet and its satellites.

The ring of Saturn gives an idea of what the nebula looked like, since it is the only part that failed to condense. The reason was that it was too close to the planet.

The compositions of the planets were determined largely by the temperatures of the regions of the cloud from which they were formed. Mercury, Venus and Earth, close to the sun, are dense materials which became solid at fairly high temperatures. Planets far from the sun, Jupiter, Saturn, Uranus and Neptune, are gases, water or ice and hydrocarbons.

Solar tides worked on the proto-planets and rotated them in the same direction as their motion around the sun. While the satellites of the planets were forming all the planets had rings like Saturn.

But the moon of the earth is an exception, according to the Kuiper theory. It was probably formed as a double planet as a partner to the earth. The earth and the moon were formed of solid matter that hailed down in a manner conceived by the earlier Chamberlin-Moulton earth origin hypothesis. The craters on the moon date from that time, and so does the Arizona meteor crater, the others on earth having been eroded away.

Earth Science Abstracts

[Selected articles on the earth sciences, appearing in current scientific publications, are abstracted here for the convenience of our readers.]

PLEISTOCENE RESEARCH

PLEISTOCENE RESEARCH, A Review by the Members of the Committee on Interrelations of Pleistocene Research, National Research Council. **Geol. Soc. America Bull.**, Vol. 60, No. 9 (Sept. 1949), pp. 1305-1526. These papers contain an exhaustive number of selected references.

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1. INTRODUCTION. Richard Foster Flint. Pp. 1305-1308. An introduction to the fields of research and to this symposium, which constitutes the Committee's First Report to the Division of Geology and Geography, National Research Council.

* * * *

2. TRENDS IN GLACIOLOGY IN EUROPE. Henry Bader. Pp. 1309-1313. Renewed activity has been shown in physical glaciology. Studies are being made on the structure, metamorphism, and mechanical properties of different types of snows.

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3. BIOGEOGRAPHY OF THE PLEISTOCENE. Edward S. Deevey, Jr. Pp. 1315-1416. The Pleistocene biogeography of Europe and North America is closely related, and the character of their problems differs sharply from that of Africa, southeastern Asia, and South America. Continental glaciation was the most extensive in Europe and North America, while high mountain glaciation and increased precipitation rather than refrigeration applied for the rest of the world. The limitations and value of biogeography are presented.

* * * *

4. PLEISTOCENE VERTEBRATE PALEONTOLOGY IN NORTH AMERICA. Claude W. Hibbard. Pp. 1417-1428. Pleistocene faunas; their shifting; speciation; and the Pliocene-Pleistocene boundary are discussed.

* * * *

5. GLACIAL EROSION AND SEDIMENTATION. Chauncy D. Holmes. Pp. 1429-1436. Glacial erosion deals with the areal description of deposits and topographic forms attributed to glaciation. Glacial sedimentation deals with search for principles of glacial erosion and deposition by which deposits and topographic forms have originated. Modes of glacial erosion, erosional topography, nature of drift, till fabric, depositional types, and paleoclimatic inferences are discussed. Problems and needed research are listed.

* * * *

6. CLIMATOLOGY OF THE PLEISTOCENE. Helmut Landsberg. Pp. 1437-1442. The problem of cause-and-effect relationships between climate and glaciation is presented. Three hypotheses on the climatic variations leading to the Pleistocene glaciations are reviewed.

* * * *

7. OLD - WORLD PALAELOLITHIC ARCHAEOLOGY. Hallan L. Movius, Jr. Pp. 1443-1456. Prehistoric archaelogy can offer very little to the natural sciences concerned wth Pleistocene research, for the taxonomic laws governing the natural sciences do not apply to this study, and artifacts can be used only very broadly as a basis of stratigraphic correlation.

* * * *

8. SUBMARINE GEOLOGY AND PLEISTOCENE RESEARCH. Fred B. Phleger. Pp. 1457-1462. An undisturbed record of the complete Pleistocene is preserved in the ocean basins. Submarine core studies should lead to a reconstruc-

tion of the late Pleistocene history of the oceans, and help in the understanding of the sequence of climatic events on adjacent lands.

* * * *

9. PROBLEMS OF PLEISTOCENE STRATIGRAPHY. Louis L. Ray. Pp. 1463-1474. Pleistocene stratigraphy must ultimately be based upon the influence on all life, environment, and attendant physical processes by the multiple climatic fluctuations which define and characterize the Pleistocene epoch. The terminology, status and problems are reviewed.

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10. ALPINE GLACIATION. Louis L. Ray. Pp. 1475-1484. Alpine glaciers are an important factor in the dynamic processes affecting the higher mountains of the earth, and are an important key to the understanding of the Pleistocene for they record in minor advances climatic fluctuations too small to produce continental glaciers. The author discusses the cirque, bergschrund, glaciated valley, alpine glacial deposits, and the glaciated mountain landscape.

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11. PHYSICAL EFFECTS OF PLEISTOCENE CLIMATIC CHANGES IN NON-GLACIATED AREAS: EOLIAN PHENOMENA, FROST ACTION, AND STREAM TERRACING. H. T. U. Smith. 1485-1516. Eolian phenomena, including dune building, loess deposition, and sand blasting; frost phenomena, including mechanical weathering, ground-ice development, solifluction, and associated processes; and stream terracing produced by alternations between aggradation and degradation are included in this discussion, which reviews the present status of investigations and presents the problems in need of study.

* * * *

12. INTERRELATIONS OF PLEISTOCENE GEOLOGY AND SOIL SCIENCE. James Thorp. Pp. 1517-1526. Soil scientists have need for information on the character of Pleistocene deposits; their physical properties; their physiographic and topographic relationships; and their stratigraphic and genetic relationships. Needed lines of study in soil genesis and rate of soil formation are listed.

PHYSICAL GEOLOGY

A HYPOTHESIS REGARDING THE ORIGIN OF THE MOVEMENT OF THE EARTH'S CRUST. Harold C. Urey. **Science,** Vol. 110, No. 2861 (Oct. 28, 1949), p. 445 (Abstract). The earth was probably formed of a uniform mixture of iron and stony phases in a cold condition, and is gradually getting warmer. A large amount of heat is generated in the earth's mantle, causing a convection in the outer mantle and the formation of mountains. An initial core was composed of moon-like material, surrounded by a layer of silicates and an iron phase. The core, after some time, rose to the surface, producing the Pacific Basin.

❖

BEACH EROSION. Joseph M. Caldwell. **The Scientific Monthly,** Vol. 69, No. 4 (Oct. 1949), pp. 229-235. The principles of shoreline types, wave action, and sand movement, are reviewed, with emphasis on the L/H (length-height) ratio of waves.

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EVOLUTION OF THOUGHT ON STRUCTURE OF MIDDLE AND SOUTHERN APPALACHIANS. John Rodgers. **Am. Assoc. Petroleum Geologists Bull.,** Vol. 33, No. 10 (Oct. 1949), pp. 1643-1654. The thoughts of the pioneer workers, the work of the U. S. Geological Survey, and recent trends are discussed. Two recent schools of thought in regard to the depth of the Appalachian deformation are that all large folds and faults extend down to and are supported by the basement, and that all the deformed rocks have been completely stripped off the basement along large bedding plane thrust faults.

METASOMATIC GRANITIZATION OF BATHOLITHIC DIMENSIONS, Part III. Peter Misch. **Am. Jour. Sci.**, Vol. 247, No. 10 (Oct. 1949), pp. 673-705. A discussion is given of the relations between synkinematic and static granitization and their criteria are summarized. Genetically synkinematic granitization is a fundamental process in geosynclinal orogeny, and static granitization is its continuation after the end of orogeny.

❖

ORIGIN OF PIMPLE MOUNDS. E. L. Krinitzsky. **Am. Jour. Sci.**, Vol. 247, No. 10 (Oct. 1949), pp. 706-714. Pimple mounds are remains of dunes and hillocks which have formed under such conditions as the environments of glacial outwash, coastal sand flats, and sandy point bars of meandering streams.

❖

THE PROBLEM OF CORAL REEFS. H. S. Ladd and J. I. Tracey, Jr. **The Scientific Monthly**, Vol. 69, No. 5 (Nov. 1949), pp. 297-305. A review of the coral-reef theories, present work on submarine geology, Bikini Atoll, and unsolved problems. Studies should be made in island geology, reefs, lagoons, submarine geology, and island foundations.

SUBMARINE GEOLOGY

GEOLOGY OF THE DEEP-SEA FLOOR. J. D. H. Wiseman. **Nature** (London) Vol. 164, No. 4173 (Oct. 22, 1949), pp. 682-684. A summary of the papers presented at the meeting of the British Association at Newcastle upon Tyne which included the following subjects: the chronology of the ocean floor; the importance of planktonic foraminifera as temperature indicators; the formation of the continental shelf; the floor of the Indian Ocean; geophysical methods for the exploration of the deep-sea floor; and manganese nodules found on the surface of the deep-sea floor of the Arabian Basin.

NEW DISCOVERIES ON THE MID-ATLANTIC RIDGE, Maurice Ewing. **The National Geographic Magazine.** Vol. 96, No. 5 (Nov. 1949), pp. 611-640. A popular account of the journey and discoveries made on the second Mid-Atlantic Ridge Expedition, aboard the **Atlantis.**

❖

THE FLOOR OF THE OCEAN. Hans Pettersson. **Endeavour** (London), Vol. 8, No. 32 (Oct. 1949) pp. 182-187. An account of the results of the **Albatross** expedition (see the report on Dr. Pettersson's paper on submarine geology, p. 13). The sediments cores obtained make up a total length exceeding an English mile, representing at least a few million years.

PALEONTOLOGY

RESEARCH IN COAL PALEOBOTANY SINCE 1943. James M. Schopf. **Economic Geology**, Vol. 44, No. 6 (Sept.-Oct. 1949), pp. 492-513. The author reviews the applications of paleobotany to coal resources studies, coal technology, and fundamental physical and chemical research on coal. In the systematic classification of plant microfossils there are two viewpoints: one essentially nonbotanical or morphologic, the other conceived on a basis of plant taxonomy.

❖

THE APE-MEN. Robert Broom. **Scientific American.** Vol. 181, No. 5 (Nov. 1949), pp. 20-24. A personal account of the South African discoveries. The author does not think that the ape-men are anthropoids, and suggests that one of them became the ancester of **Homo sapiens.**

❖

THE RIDDLE OF MAN'S ANCESTRY. William L. Straus, Jr. **The Quarterly Review of Biology**, Vol. 24, No. 3 (Sept. 1949), pp. 200-223. The author concludes that available evidence indicates that the line leading to man became independent at a relatively early

date, probably no later than the Upper Oligocene, and that the stock from which it arose was essentially monkey-like rather than anthropoid-like.

PETROLOGY

CERAMIC PRODUCTS: THEIR GEOLOGICAL INTEREST AND ANALOGIES. W. O. Williamson. **Am. Jour. Sci.,** Vol. 247, No. 10 (Oct. 1949), pp. 715-749. **Processes thought to be operating in petrogenesis, such as the shaping of clays and the deformation of rocks, are analogous to some phenomena of the ceramic industries.**

❖

INTERPRETIVE PETROLOGY OF SEDIMENTARY ROCKS. Gordon Rittenhouse. **World Oil,** Vol. 129, No. 7 (Oct. 1949), pp. 61-66. **An outline of the principles of the interpretive petrology of sedimentary rocks is given, with emphasis on the examination of thin sections with the petrographic microscope.**

MISCELLANEOUS

ALASKA AND THE GEOLOGICAL SURVEY. John C. Reed. **The Scientific Monthly,** Vol. 69, No. 4 (Oct. 1949), pp. 242-248. **The program of the Geological Survey in Alaska includes work in general, military, and engineering geology, geophysics, mineral investigations, permafrost study, topographic mapping, and water resources investigations. Factors in Alaska's development and major future problems are treated.**

❖

THE THEORY OF MICROMETEORITES. Fred L. Whipple. **Science,** Vol. 110, No. 2861 (Oct. 28, 1949), p. 438 (Abstract). **The micrometeorite is an extraterrestrial body that is sufficiently small to enter the earth's atmosphere without being damaged by encounter with the atmosphere. Deep oceanic sediments, polar snows, or even geological strata, may contain evidences of these particles.**

Ancient Ax-Heads Made of Bone Discovered

LONDON, Oct. 9 (Science Service — Discovery of ancient bone ax-heads that led stone age man on the banks of the Nile to invent a better kind of stone ax copied from the bone ones is reported by Dr. A. J. Arkell of London's University College Department of Egyptology.

This new chapter in how the ax with a handle come to be developed archaeological site of Esh Shaheinab on the west bank of the Nile, excavated by the Sudan Government Antiquities Service this year.

Eleven polished bone ax-heads, ranging from the eight to three inches in length, were found. There were made from long bones of the hippopotamus, rhinoceros, elephant and perhaps other animals. Fragments of 65 other axes were found. All had been given a sharp cutting edge by rubbing on sandstone grinders used by the ancient men for grinding red ochre, favorite coloring material for decorating themselves.

Along with the ax-heads, many stone-axes were discovered in the same hearth layer of soil representing many campfires. The stone tools were generally smaller although some were the same size as the bone ones.

Dr. Arkell in his communication to the British journal, *Nature*, explains that the hunters of the large animals probably first used large splinters of the animal bones for hacking meat off their kill. The next step was to fit the splinter into a wooden handle, making a more efficient hacking tool.

That was the invention of the ax. They naturally tried the new tool on wood, perhaps in hollowing out dug-out canoes and for making spear-throwers. But when the bone ax was not strong enough to cut any but the softest woods, they copied the bone ax in stone.

Gas Escaped From Underground Petroleum Reduces Flow of Oil To Output Wells

ANN ARBOR, Mich., Oct. 22 (Science Service) — It is gas released from petroleum deep underground that reduces or prevents the flow of the crude oil through the oil-bearing rock into the well bore which leads to the surface of the ground, according to Dr. Donald L. Katz, professor of chemical engineering here at the University of Michigan.

This belief was recently discussed by him at a San Antonio, Tex., meeting of the American Institute of Mining and Metallurgical Engineers. Rapid decrease in the fluid output of some oil wells may now be explained, he said. The low production is mainly due to phenomena occurring when the pressure of the oil is reduced to a point where the gas escapes from the petroleum.

The gas is then absorbed by the porous sandstone rock, thereby reducing the ability of the oil-bearing rock to conduct the liquid to the well. The rate at which the oil pressure drops is dependent upon the type of sandstone configuration that contains the oil deposit. When oil passes from a large pore in the sandstone bed to a smaller pore, the velocity increases and the pressure drops, he stated. The gas then escapes.

When oil wells gradually stop pouring forth crude oil the only solution has been to shut the wells down until the pressure increases. In this period the liberated gas is reasorbed by the liquid and the crude oil can then flow quite freely. With a clearer understanding of the activity occurring when oil pressure is reduced, petroleum engineers can now work more effectively to prevent the slowing down of production.

The conclusions of Dr. Katz are based on investigations conducted to study the permeability of sandstone samples when oil at different pressures was passed through the material.

Dinosaur For Sale!

ROCHESTER, N. Y., Nov. 1 — The discovery of a practically complete specimen of the dinosaur, *Mystriosaurus zollensis*, in Holzmaden, Germany, was announced today at Ward's Natural Science Establishment, Inc., noted museum supply firm of Rochester, N. Y.

Measuring approximately 15 feet in length, the 150 million year old specimen, while far from the largest of prehistoric animals, is unique in respect to its relatively intact condition. Authorities at Ward's, the owner's agents, report that such a find is one not likely to be duplicated in decades.

Salvaging of the *Mystriosaurus*, following its discovery over a year ago, involved not only excavating it from the rock in which it was embedded, but, also, months of most delicate hand labor in removing the rock from around the intricate form of the animal. As at present fully prepared for sale, it is to be seen in the manner of a relief on a plaque of the same stone which originally underlay it. It may be purchased in this form at the post-devaluation price of $3,000 (F.O.B. Holzmaden, Germany). Prospective purchasers may contact Ward's Natural Science Establishment, Inc. for photographs and other details.

New Books

All books listed here are deposited in the Library of The Earth Science Institute and may be borrowed by the members. Books marked with an asterisk may be purchased through The Earth Science Publishing Co., Revere, Mass.

*GENETICS, PALEONTOLOGY, AND EVOLUTION.

Edited by Glenn L. Jepsen, Ernst Mayr, and George Gaylord Simpson, for the Committee on Common Problems of Genetics, Paleontology, and Systematics, of the National Research Council. 1949. 474 pp., 1 pl., 44 fig.; $6.00. (Princeton University Press, Princeton, N. J.) In this volume, various aspects and implications of organic evolution are presented in 23 papers by the leading workers in genetics and paleontology, including Drs. Chaney, Colbert, Davis, Ford, Haldane, Hovanitz, Just, Knopf, Lack, Mason, Mayr, Moore, Muller, Patterson, Romer, Simpson, Spencer, Stebbins, Stern, Watson, Wood, Westoll, and Wright. Among the subjects treated are viewpoints on evolution, evolutionary trends, evolutionary rates, speciation, adoption, and human evolution. An outstanding glossary of technical terms based on the usage of the book is provided by the editors.

GEOLOGY AND MINERAL DEPOSITS OF FILE-TRAMPING LAKES AREA, MANITOBA.

J. M. Harrison. 1942. 92 pp., 4 pls., 7 figs., 3 maps; $0.25. (Memoir 250, Geological Survey of Canada). This area is part of the Flin Flon-Sherridon-Herb Lake Mineral Belt. This report is concerned chiefly with the Pre-Cambrian succession of events in the more easterly part of the mineral belt, and the mineral deposits contained in it.

OIL AND GAS DEVELOPMENTS IN KANSAS DURING 1948.

W. A. Ver Wiebe, J. M. Jewett, and E. K. Nixon. 1949. 186 pp., 53 fig.; $0.25. (Bulletin 78, State Geological Survey of Kansas, Lawrence, Kansas). Kansas oil and natural gas production reached an all-time high in 1948. Secondary oil recovery is increasing rapidly in importance.

PRELIMINARY REPORT ON PHOSPHATE-BEARING SHALES IN EASTERN KANSAS.

Russel T. Runnels. 1949. 12 pp., 2 pls.; $0.10. (Bulletin 82, Part 2, State Geological Survey of Kansas, Lawrence, Kansas). Phosphate-bearing bituminous shales of Pennsylvanian age from 5 Kansas counties contain enough phosphate and trace elements to be of value as a source of agricultural fertilizer.

JURASSIC FORMATIONS OF MAUDE ISLAND AND ALLIFORD BAY, SKIDEGATE INLET, QUEEN CHARLOTTE ISLANDS, BRITISH COLUMBIA.

F. H. McLearn. 1949. 20 pp., 3 figs.; $0.25. (Bulletin No. 12, Geological Survey of Ottawa, Canada). The definitions, lithological and faunal successions, modes of origin, and ages of the Maude and Yakoun formations are given.

INDIN LAKE (EAST HALF) MAP-AREA, NORTHWEST TERRITORIES.

Y. O. FORTIER, 1949. 28 pp., map; $0.10. (Paper 49-10, Geological Survey of Canada, Ottawa). Most of the area is underlain by granitic rocks, the remainder by sedimentary and volcanic strata of the Yellowknife group and their metamorphic derivatives, which form aureoles against the granitic masses.

FORGET LAKE AREA, SAGUENAY COUNTY.

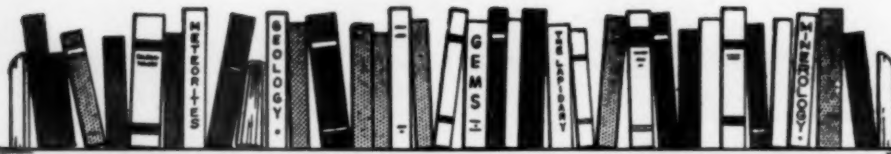
W. W. Longley. 1948. 25 pp., 8 pls., map; free. (Geological Report 36, Geological Surveys Branch, Quebec Dept. of Mines, Quebec). The underlying consolidated rocks are Pre-Cambrian, consisting of a sedimentary series, probably Grenville in age. River and lake gravels contain considerable amounts of ilmenite sands.

COAL DEPOSITS OF THE SANTA CLARA DISTRICT, SONORA MEXICO.

I. F. Wilson and V. S. Rocha. 1949. 85 pp., 12 pls., 3 figs.; $1.00. (Bulletin 962-A, U. S. Geological Survey, Washington, D. C.). This highly metamorphosed coal occurs in the Barranca formation of Upper Triassic and Lower Jurassic (?) age, a thick sequence of marine and non-marine beds of quartzitic sandstones, conglomerates, shales, and intercalated coal beds. Measured reserves total 30,000 tons; indicated reserves, 230,000 tons; inferred reserves, 2,000,000 tons; and possible reserves, 4,000,000 tons.

THE FORAMINIFERAL FAUNA OF THE UPPER CRETACEOUS ARKADELPHIA MARL OF ARKANSAS.

J. A. Cushman. 1949. 22 pp., 4 pls.; $0.40. (Professional Paper 221-A, U. S. Geological Survey, Washington, D. C.) Of 115 species recognized, 93 are listed and illustrated; 19 are listed with references to descriptions in Prof. Paper 206 (Upper Cretaceous Foraminifera of the Gulf Coastal Region, by Cushman); and 3 are both described and illustrated.



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CERAMICS — CLAY TECHNOLOGY by Hewitt Wilson. 1927. 296 pp. 4.00

COAL: ITS PROPERTIES, ANALYSIS, CLASSIFICATION, GEOLOGY, EXTRACTION, USES AND DISTRIBUTION by Elwood S. Moore. 2nd Edition. 1940. 473 pp. 6.50

CONSERVATION OF NATIONAL RESOURCES by George T. Renner. 1942. 228 pp. 3.25

EARLY DAYS OF OIL: A Pictorial History of the Beginnings of the Industry in Pennsylvania by Paul H. Giddens. 1948. 150 pp., illus. 6.00

ECONOMIC GEOLOGY by H. Ries. 7th Edition. 1937. 720 pp., illus. 5.50

ECONOMIC MINERAL DEPOSITS by Alan M. Bateman. 1942. 898 pp. 7.00

ELEMENTARY ECONOMIC GEOLOGY by H. Ries. 1930. 360 pp., illus. 4.00

ELEMENTS OF ENGINEERING GEOLOGY by H. Ries and Thomas L. Watson. 2nd Edition, revised. 1947. 496 pp., illus. 5.50

ENGINEERING GEOLOGY by H. Ries and Thomas L. Watson. 5th Edition. 1936. 750 pp., illus. 6.00

FIELD GEOLOGY by Frederick H. Lahee. 4th Edition. 1941. 853 pp., 599 illus. 5.50

GEOPHYSICAL EXPLORATION by Carl A. Heiland. 1940. 1013 pp., illus. 10.00

GEOPHYSICAL PROSPECTING FOR OIL by L. L. Nettleton. 444 pp., illus. 5.50

MESSVERFAHREN DER FUNKMUTUNG by Volker Fritsch. In German. 1943. 220 pp. 6.75

MINERALS IN MODERN INDUSTRY by Walter H. Voskuil. 1930. 350 pp. 4.00

OCEAN WAVES AND KINDRED GEOPHYSICAL PHENOMENA by Vaughan Cornish. 1934. 164 pp., illus. 3.00

OIL FOR VICTORY by the Editors of Look. 1947. 287 pp., 217 illus. 3.50

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